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Preoperative ICD risk score variables predict 30-day readmission after implantable cardioverter defibrillator implantation in patients with heart failure

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ABSTRACT

Objective: To determine if preoperative ICD Risk Score for Adverse Outcome (ICD-RSAO) would predict need for hospital 30-day readmission.
Background: Pre-analysis of National Cardiovascular Data Registry ICD database identified preoperative predictors of adverse outcomes associated with ICD implantation.
Methods: Logistic regression, descriptive statistics and Chi-square were used to examine the relationship between ICD-RSAO and 30-day readmission after ICD implantation.
Results: BUN >30, history of lung disease, NYHA Class IV and device implant during inpatient stay were predicative of 30-day readmission ($P = 0.001$; 95% CI = 0.58–0.79). Patients with a combination of two or more of four variables were more likely to be readmitted (Hosmer–Lemeshow ($\chi^2 = 3.44$, $P = 0.49$), c-statistic = 0.71, and Nagelkerke $R^2 = 0.15$).
Conclusion: Patients who have elevated BUN's, NYHA Class IV, chronic lung disease and ICD implantation during a concomitant hospital admission are at increased risk for readmission and need early follow up.

Introduction

Implantable cardioverter defibrillator (ICD)[c] implantation is routinely employed in a wide range of patients at risk for sudden cardiac death.[1,2] There are inherent risks for post procedure complications, including lead dislodgement, infection, unnecessary ICD firings, and worsening heart failure symptoms.[3–5] Specific risk factors, such as chronic kidney disease, increase heart failure (HF)[d] burden and number of previous hospitalizations and length of stay, have been found to put patients with HF at increased risk for re-hospitalization.[5–7] It has been reported that the 30-day readmission rate for patients undergoing ICD implantation was 12.5%, with 45% of those patients being readmitted for heart failure symptoms.[8] The Affordable Care Act has identified the 30-day readmission as a surrogate for quality of care.[9] Therefore, identifying patients who are at increased risk for 30-day readmission after ICD implantation necessary.

Predicting re-hospitalization in patients after ICD implantation had not been previously studied, even though ICD related complications had been.[3–8] An analysis of the National Cardiovascular Data Registry (NCDR) ICD database identified preoperative predictors of adverse in hospital outcomes associated with ICD implantation, and showed promise as a predictor for 30-day readmission.[10] As a starting, point we hypothesized that the ICD Risk Score for Adverse Outcome (ICD-RSAO)[e] would also predict late complications and need for hospital readmission in a real life setting of ICD implantation in a busy tertiary care community hospital. Additional study objectives were to (a) examine the predictability of the individual ICD-RSAO variables, (b) determine a composite that is most predictive of 30-day readmission, and (c) examine the sensitivity, specificity, positive and negative predictive value of the composite variables for predicting 30-day readmission.

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[c] Implantable cardioverter defibrillator = ICD.
[d] Heart failure = HF.
[e] ICD Risk Score for Adverse Outcome = ICD-RSAO.

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Methods

The study was approved by the Departments of Nursing Research and Scholarship and the Beaumont Human Investigation Committee. It was conducted in a tertiary suburban hospital in the Midwest between December 1, 2012 and December 31, 2013. Since the patients who were scheduled for an outpatient elective generator change (no lead placement or revision) would be discharged home the same day of the procedure, they were excluded from the analysis. The charts for these patients were reviewed prior to the procedure and each patient assigned an ICD-RSAO score either pre or post procedure.

ICD-RSAO was calculated for each patient using the variables and algorithm determined by Haines et al[10]: assigning age >70 years (1 point), atrial fibrillation (1 point), New York Heart Association class III (1 point) or IV (3 points), female (2 points), chronic lung disease (2 points), blood urea nitrogen >30 (2 points), prior valve surgery (3 points), ICD type dual chamber (2 points) or biventricular (4 points), ICD implantation as part of concomitant hospital admission for another indication (3 points), and patients admitted for ICD device change for reasons other than battery depletion (6 points).[10] Patients were classified by total risk score as low (≤5), intermediate (6–9), high (10–18), or very high risk (≥19). The patients were followed prospectively for 30 days. The primary outcome event was: 30-day hospital readmission for any cause.

Statistical analysis

First, logistic regression was used to examine the relationship between the ICD-RSAO and 30-day readmission using the predetermined scoring algorithm. Model fit was tested with the Hosmer–Lemeshow test and the c statistic was calculated to determine test discrimination. Second, each of the ICD-RSAO risk variables was coded as a simple yes/no dichotomy. Variables with two categories were coded 1 for risk and 0 for no risk and multiple category variables were dummy coded to represent contrasts. Chi-square was used to examine the association of these variables and 30-day readmission. Third, stepwise logistic regression was used to determine the smallest subset of variables and the linear composite most predictive of 30-day readmission. This was followed by a receiver operating characteristic (ROC) analysis to determine area under the curve (AUC), sensitivity, and specificity, negative and positive predictive values.[11]

Results

A total of 323 ICDs were implanted during the study period between December 1, 2012 and December 31, 2013, of whom 141 patients were scheduled for generator changes and discharged the same day as the procedure were excluded from the analysis. The remaining 182 patients comprised the study group. Patients were 69 ± 11 (range 37–91) years, with 69% male, and a mean left ventricular ejection fraction of 26 ± 10%. There was an equal number of inpatients ($n = 91$) and outpatients ($n = 91$). The mean ICD-RSAO risk score was 7.95 ± 3.86. Thirty two patients (17.58%) were readmitted within 30 days. The most common reason for readmission was heart failure (53%; $n = 17$), followed by ICD shocks for ventricular tachycardia and ventricular fibrillation (25%, $n = 8$) and lead revision (9%, $n = 3$). One patient died within 30 days of ICD implant hospitalization.

The ICD-RSAO stratification is shown in Table 1. Contrary to expectations, the ICD-RSAO stratification was not significantly associated with 30-day readmission ($\chi^2(3) = 6.37$, $P = 0.095$). Only the highest risk category was significantly associated with risk for readmission (Table 1). However, this category consisted of only 3 patients and the 95% confidence interval was very wide. Due to the small number of patients at the highest risk classification level one could regard these results as inconclusive. The bivariate logistic regression of 30-day readmission on continuous ICD-RSAO score was mildly significant (OR = 1.11; 95% CI (1.01, 1.22), $P = 0.031$). The association of individual ICD-RSAO variables with 30-day readmission is shown in Table 2. The two strongest predictors were blood urea nitrogen >30 mg/dl (BUN) ($P = 0.001$) and New York

Table 1
ICD risk score for adverse outcome by classification, $N = 182$.

Risk stratification score	*n*	%	OR	CI	*P*-value
1. Low risk (≤5) (reference level)	44	24	–	–	–
2. Intermediate risk (6–9)	80	44	2.3	0.71–7.44	0.162
3. High risk (10–18)	55	30	2.5	0.74–8.48	0.142
4. Very high risk (≥19)	3	2	20.0	1.42–272.32	0.025

Table 2
ICD risk variables, scoring algorithm for ICD-RSA0, and prediction of 30-day readmission, $N = 182$.

ICD risk variables categories (no.)	Risk category (points)[a]	% Readmit[b] ($n = 32$)	χ^2 *P*-value
Overall 30-day readmit %		17.6%	
Atrial fibrillation			
No (123)	Low (0)	14.6%	
Yes (59)	High (1)	23.7%	
	H – L	9.1%	0.13
Blood urea nitrogen >30 mg/dl			
No (138)	Low (0)	12.3%	
Yes (44)	High (2)	34.1%	
	H – L	21.8%	0.001
ICD implant			
Elective ICD implant (126)	Low (0)	14.3%	
ICD implant during hospitalization (56)	High (3)	25.0%	
	H – L	10.70%	0.08
Age >70			
37–60 (94)	Low (0)	13.8%	
61–91 (88)	High (1)	21.6%	
	H – L	7.8%	0.17
Gender			
Male (126)	Low (0)	16.7%	
Female (56)	High (2)	19.6%	
	H – L	2.9%	0.63
Previous valve surgery			
No (167)	Low	18.0%	
Yes (14)	High	7.1%	
	H – L	−10.9%	0.30
Reimplantation for reasons other than battery change			
No (161)	Low (0)	17.4%	
Yes (21)	High (6)	19.0%	
	H – L	1.6%	0.85
Chronic lung disease			
No (149)	Low	15.4%	
Yes (33)	High	27.3%	
	H – L	11.9%	0.11
New York Heart Association class			
Class I + II ($n = 116$)	Low (0)	18.1%	
Class III ($n = 55$)	Medium (1)	10.9%	
Class IV ($n = 11$)	High (3)	45.5%	0.02[c]
	M – L	−7.2%	0.23
	H – L	27.4%	0.03
ICD type			
Single chamber (47)	Low (0)	23.4%	
Dual chamber (50)	Medium (2)	14.0%	
Bi-ventricular (85)	High (4)	16.5%	0.45[c]
	M – L	−9.4%	0.23
	H – L	−6.9%	0.33

[a] Points used to weight variables in the ICD-RSA0 score.
[b] Conditional probability/percent of 30-day readmission for each level of risk.
[c] Overall chi-square with 2 df, all other chi-square tests are 1 df.